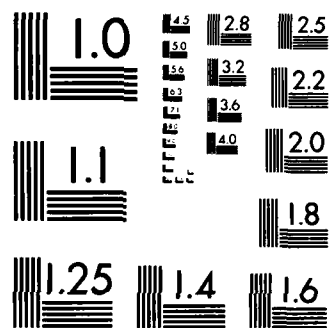


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IMPROVING MILSATCOM ACQUISITION OUTCOMES:
LEASE VERSUS BUY

F. M. Dinneen, T. H. Quinn

January 1985

N-2209-AF

Prepared for

The United States Air Force

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A RAND NOTE

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P. M. Dinneen, T. H. Quinn

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PREFACE

This study was requested by the Director of Space Systems and Command, Control, and Communications, Office of the Deputy Chief of Staff (Research, Development, and Acquisition), Headquarters United States Air Force, to assist in improving the outcomes of military satellite communication (MILSATCOM) programs. In view of rapidly rising costs of military space systems, leasing has been suggested as one way of controlling these costs. The purpose of this study, therefore, was to identify and analyze the central considerations relevant to determining whether to lease or buy MILSATCOM services. The results of this report should be of interest to members of MILSATCOM acquisition community and others concerned with making lease versus buy decisions in the public sector. The work was conducted under the "MILSATCOM Acquisition Policy" project of the Project AIR FORCE Resource Management Program.

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SUMMARY

This Note attempts to separate fact from fiction in the public policy debate over whether to lease or buy military satellite communication (MILSATCOM) systems. Over the next decade, MILSATCOM systems will cost taxpayers billions of dollars. The magnitude of these costs and their distribution in the economy will be directly affected by whether public policymakers choose to lease or buy these systems.

In recent years, MILSATCOM acquisition strategies have come under heavy criticism, especially from the Congress and GAO. In 1977, a staff report for the House Appropriations Committee strongly recommended that "[h]enceforth, DoD should, in the Committee's view, lease and not buy communication satellites." According to the House Report, leasing would shift risks to the private sector and provide strong incentives to satellite suppliers to avoid costly and unnecessarily complex communication systems. As a result, the HAC staff contended that leasing would reduce cost overruns, schedule delays, and management problems and improve system performance.

In response, the Air Force, DCA, OSD, and other organizations argue that leasing will result in the loss of vital DoD control over system development, lead to performance and technological characteristics that compromise national security, and dramatically increase the costs of acquiring MILSATCOM systems. Indeed, some DoD studies have argued that leasing instead of buying would increase MILSATCOM costs by as much as 200 percent.

Past leasing experiences with three MILSATCOM systems, MARISAT, TDRS, and LEASAT, suggest other rationales underlying the motives to lease rather than buy MILSATCOM. For example, some argue that leasing is desirable because the DoD satellite user can compete for funds from operation and maintenance accounts rather than from construction accounts in the defense budget. In other cases, leasing has occurred because of its tax consequences for defense contractors. Another argument is that leasing allows DoD to exploit economies of scale by sharing satellite capacity with other users.

This Note examines the conclusions of leasing's opponents and proponents and the arguments suggested by past leasing experiences. Most of the past arguments do not provide a useful basis for making lease versus buy decisions. Our analysis demonstrates that by far the most important consideration in deciding whether to lease or buy MILSATCOM systems is the cost of risk bearing. This issue has been largely ignored in the policy debate.

Leasing and buying differ most fundamentally in how they distribute the risks inherent in the development and operation of a MILSATCOM system. Under a purchase, risks are borne by taxpayers, who must pay the contractor for satellites even if they fail to perform as anticipated. Under a lease, these risks are borne by the shareholders of defense contractors, who receive no payments when they cannot deliver specified services. The differences in the distribution of risk under alternative forms of contract can have powerful effects on the total costs of satellite communications to the economy.

Our analysis of the costs of risk bearing demonstrates that:

- While leasing itself does not alter MILSATCOM *technical* risks, it does result in a different distribution of *financial* risks.
- Leasing will usually increase budgetary costs relative to a purchase. This budget cost gap will increase with the technical riskiness of the MILSATCOM system.
- Budget costs under a purchase understate the social costs of providing communications services. To compare lease and buy costs on an equal basis, it is necessary to add a risk premium for taxpayers to the budget costs of the buy option.
- Actual costs of risk bearing reflect several economic characteristics including:
 - the nature of technical risks;
 - the correlation of risks posed by a MILSATCOM investment with risks posed by other investments in the economy;
 - the ability of the government to hedge risks;
 - the distribution of system costs among taxpayers under a purchase and among private sector shareholders under a lease;
 - the risk preferences of these groups.

Because past arguments have focused on "out-of-pocket" budget expenditures and not on the broader social costs of risk bearing, previous analyses of lease versus buy decisions have been imbalanced. In general, the appropriate choice between leasing and buying will vary from one MILSATCOM system to another.

Based on our analysis, we suggest that DoD consider soliciting bids that specify terms for both lease and buy options on MILSATCOM systems. The competitive bidding system has the potential to provide a great deal of information important to policy decisions on risk bearing. This revision in the bidding process would lay the groundwork for determining the most cost-effective combination of construction costs and risk costs--both of which warrant full consideration in the acquisition process. The added information could also be used to develop improved methods of risk hedging that could reduce the costs of risk bearing.

Over the longer term, the costs of public risk bearing in the context of MILSATCOMs should be examined more comprehensively. Before long-term policy decisions can be made to guide lease versus buy choices, several basic questions require further analysis. These include:

- What is the "risk incidence" under alternative contracts? That is, how are risks distributed among taxpayers under a purchase and among shareholders under a lease?
- What options are available for risk spreading and what constraints are relevant under a lease and under a purchase?
- How does the risk imposed on individuals by the financing of a MILSATCOM system affect typical investment *portfolios*, since portfolio effects ultimately determine the cost of risk?
- Are there important differences between the risk preferences of those who bear risk under a lease and those who bear risk under a purchase?

ACKNOWLEDGMENTS

Several current and former Rand staff members contributed ideas and research findings to this study, including Frederick Biery, Arturo Gandara, William Harris, Robert Heavner, Karl Hoffmayer, Kenneth Horn, and Allen Lee. We were also aided significantly by two U.S. Air Force Rand Research Fellows who participated as members of the study team, Major C. E. Whited and Major E. Simmons; and by numerous representatives of the communications satellite industry. Responsibility for any errors in fact or interpretation resides with the authors, however.

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I. INTRODUCTION

Military satellite communication (MILSATCOM) systems are particularly important because they are costly (in the next decade, new systems and major upgrades will probably cost \$10 billion or more) and vital for warfighting command, control, and communications. Therefore, acquisition strategies for MILSATCOM systems must not only be cost-effective, but also provide highly reliable services when and where they are needed. The problem, however, is "how" to achieve these desired acquisition outcomes.

One paramount issue in the debate is the choice of a contractual mechanism through which the government acquires communication services. In the past, we have relied primarily on communication systems that are purchased outright from private corporations. However, the government could instead lease communication services from the satellite manufacturer or others in the private sector who retain ownership rights. This Note examines some of the important considerations involved in this public policy choice.

In recent years, MILSATCOM acquisition strategies have been criticized, especially by Congress and the GAO,¹ for excessive cost overruns, schedule delays, poor management, and unsatisfactory performance. Searching for a way to improve MILSATCOM acquisition outcomes, the House Appropriations Committee (HAC) in 1976 commissioned its staff to investigate current problems and alternative acquisition strategies. The results are documented in the *House Surveys and Investigations Report*, 1977.²

The HAC staff found cost overruns and schedule delays in many MILSATCOM programs. They attributed the problems primarily to system complexity--arising from "unique and vital" warfighting requirements

¹"Relative Performance of Defense and Commercial Communications Satellite Programs," Report by the Comptroller General, General Accounting Office, LCD-79-108, August 10, 1979.

²House Appropriations Committee, *Surveys and Investigations Report*, 1977.

such as physical and electronic survivability. These requirements typically entail major technological advances that are not only costly and risky, but, in the staff's opinion, perhaps unnecessary or ineffective. Furthermore, the staff believed that contractors tend to underestimate costs during the early stages of research and development and revise cost estimates upwards during the production stage to ensure adequate profits after paying for design changes, unanticipated technical problems, schedule delays, and other factors. Consequently, the HAC report argued that major changes in acquisition strategies were necessary to improve acquisition outcomes.

In evaluating alternative acquisition strategies, the staff noted that, in contrast to the military sector, the commercial sector, which relies more heavily on leasing, seemed to achieve superior results with respect to cost, schedule, and performance goals. Furthermore, in reviewing MILSATCOM satellite programs, the HAC staff found that the only satellite system meeting expected goals is a leased, shared, and commercial system--MARISAT.³ Finally, the House Report recommended that "[h]enceforth, DoD should, in the Committee's view, lease not buy communication satellites."

In contrast, the Air Force, DCA, OSD, and other organizations have strongly opposed increased reliance on leasing MILSATCOM systems, arguing that leasing will dramatically increase the costs of satellite communication services. The opponents of leasing also question the ability of this type of contract to guarantee desired levels of performance and technology, especially in the case of high-risk, wartime communication systems.

In short, the choice of an appropriate MILSATCOM contractual mechanism has been highly controversial. This controversy has generated several studies in recent years. In 1977, the House Appropriations Committee announced that it would not approve funding requests for any new MILSATCOM systems unless such requests were justified by an adequate lease versus buy analysis. Accordingly, DoD commissioned several studies for a proposed follow-on to the Navy's FLTSATCOM Program⁴ and

³The MARISAT Program is discussed in Section II below.

⁴"Report of a Study of Costs of Lease or Purchase of Satellites for Navy Communications," Satellite Systems Engineering, Inc., October 17, 1977.

for a proposed new strategic satellite system.⁵ Still other studies were conducted for government leasing programs such as NASA's Tracking Data Relay Satellite (TDRS).⁶

The results of these studies have been mixed, as have actual experiences with leasing of MILSATCOM services. The central analytical task, of course, is not to compare leasing with some absolute standard, but to compare leasing outcomes with those that would occur under a "buy" program in the same circumstances. Because of the difficulties of this type of analysis, a definitive study of MILSATCOM leasing has yet to be undertaken. Past studies have not yet adequately defined the central issues in the choice between leasing and buying. This Note attempts to separate the numerous peripheral issues that have arisen from the central questions affecting the performance of lease versus buy contracts.

Ultimately, the choice of lease versus buy depends most importantly upon considerations of *risk bearing*. All MILSATCOM systems are subject to some technical risk. The primary difference between buying and leasing a communication system lies in where in our economy the corresponding financial risks are borne: by taxpayers in the case of purchase, or by shareholders of private corporations in the case of leasing. Thus, an important--and uniformly overlooked--question is whether these risks can be borne at a lower cost in the private or public sector.

Section II of this note provides necessary background information by defining lease and purchase contracts and summarizing past private and public leasing experience. Section III summarizes and criticizes arguments previously advanced in the lease versus buy debate and examines a variety of issues related to the cost of risk bearing. Whether MILSATCOM risks are privately or publicly borne may affect the social costs of communication systems by billions of dollars. Social costs summarize all the costs imposed in the economy, including both the

⁵"Lease versus Buy Considerations for MILSATCOM Systems and An Acquisition Strategy for STRATSAT," MILSATCOM System Office (MSO) Draft, Technical Report No. 80-1, March 28, 1980.

⁶J. M. Burgess and R. T. Wolf, "Economic Analysis of Lease vs. Buy Alternatives for the NASA Tracking and Data Relay Satellite System," the MITRE Corporation, February 15, 1973.

costs of constructing and operating a communication system and the cost of bearing risk. Section III identifies some of the circumstances that affect the choice of the least costly form of contract. Section IV summarizes conclusions of the analysis and identifies directions for future research.

II. GENERAL BACKGROUND ON LEASING

WHAT IS A LEASE?

A lease is a form of contract that defines conditions of ownership and use for a specific asset. In the standard textbook definition, leasing is an agreement that conveys to the lessee the right to use a specific property for a particular period of time in return for a stipulated (usually periodic) cash payment. These payments are made to the other party, the lessor, who holds the title or ownership rights to the leased property.¹

To understand the economic implications of this form of contract, it is important to consider what it means to be the "title holder" of an asset. In economic terms, the title holder has the right to claim the financial residual resulting from the use of an asset. That is, the "residual claimant"² has the right to the profits (or losses) remaining after payments to other factors of production. The title holder of an asset enjoys a gain when the asset increases in value and suffers a loss when the asset decreases in value.

The primary distinction between leasing and buying MILSATCOM systems is the identity of the residual claimants or title holders under these two kinds of contract. For a purchased system, the title to the resources embodied in the communication system is transferred unconditionally to the government. If the system is extraordinarily productive, the government--or, more accurately, taxpayers--enjoy a windfall gain. If the purchased system fails, taxpayers bear the loss from devaluation of their capital investment, because the satellite will never realize its expected returns and may have to be replaced altogether.

¹See Kieso and Weygandt (1977) p. 924.

²For a discussion of the importance of this concept in economic theory, see Alchian and Demsetz (1972).

Under a lease, the owners of private firms, either the satellite manufacturer or others, become the residual claimants, and the government contracts only for communication services. If the system is unexpectedly productive, when the term of the lease expires the rental value of the satellite will increase, to the benefit of the private sector satellite owners. If the purchased system fails, taxpayers have no legal obligation to pay for it, and the cost burden falls on the shareholders of private firms that hold the satellite title.

PRIVATE SECTOR LEASING

In the last decade leasing has become a popular method of financing equipment in the private sector. Over 20 percent of all capital acquired today is obtained using this technique.³ Regulatory and economic events precipitated the leasing explosion of the 1970s. The first regulatory changes began in 1963 when the Comptroller of the Currency allowed banks to lease personal property. This prompted banks to establish leasing departments and staffs with sophisticated financial and marketing skills. Then, in 1971, the Federal Reserve Board allowed member banks to form holding companies to engage in equipment leasing. Other economic events, specifically the liquidity crisis of 1969-1970, caused many corporate treasurers to consider alternative financing schemes. These economic and regulatory factors led to a rapid increase in leasing. Between 1968 and 1973 the value of leased goods doubled.⁴

Today leasing is estimated to be a \$150 billion per year activity.⁵ The biggest segments of the leasing market involve data processing equipment, railroad rolling stock, and transportation vehicles. Recently municipal and state governments and other public enterprises have used leasing to finance computers, communication systems, vehicles, and medical equipment.⁶ Private firms or public institutions can lease virtually any kind of equipment.

³This estimate excludes oil and gas leases. See Davey (1980), p. 1.

⁴Vanderwick (1973) and Laing (1973).

⁵"Leasing Companies Hope to Get a New Lease on Prosperity," *Wall Street Journal*, February 26, 1981, p. 1; "Faster Write-Offs May Spur Leasing," *Business Week*, March 23, 1981, pp. 95-96.

⁶American Association of Equipment Lessors, "Leasing: A Creative Force in Asset Financing," *Fortune*, August 27, 1979.

Private sector leasing can have important tax implications, and the potential for tax savings underlies much leasing activity. Leasing also provides a contractual vehicle that separates the development, operation, and use of a piece of capital equipment from the financial risk bearing associated with it. In the private sector, potential lessors and lessees have access to private financial markets for insurance and securities to hedge investments in such risky assets as communication satellites. Leasing, combined with access to financial markets, allows risks to be shifted to those who can bear them at a lower cost.

The primary types of leases are the following:⁷

Finance Leases. A form whereby a lessee can acquire the use of an asset for most of its useful life. The lessee is responsible for maintenance, taxes, and insurance. The lessor is interested not in managing the asset, but in receiving a return on his investment. Capital leases, direct financing leases, sales-type leases, and leveraged leases are different popular forms of finance leases.

Operating Lease. This is a short-term mode of leasing, extending for considerably less than the leased asset's useful life. To recover the costs of the asset and earn a return, the lessor depends on renewing the initial lease with the initial lessee or leasing the asset to another customer. The lessor generally pays the taxes, insurance, and maintenance costs on the asset.

Leveraged Lease. Probably the most complex type of lease, a leveraged lease involves not only the lessor and lessee but a third party--a long-term lender to the lessor. This third party lends funds (usually a substantial portion of the asset's cost) to the lessor to purchase the asset to enable the lessor to lease it to the lessee. For repayment, the third party lenders agree to look solely to the proceeds available from the leased asset. This form of leasing is most often used in large capital equipment projects that are usually eligible for investment tax credit.

⁷For more detailed definitions of the various types of leases, see Bank AmeriLease Group, *Direct Leasing*, Bank American Companies 1980, pp. 43-47.

PUBLIC SECTOR LEASING

In the public sector, the leasing and buying of productive resources are subject to the same contractual underpinnings as in the private sector, but the institutional setting for contractual choice differs. Because the government obviously does not pay taxes, tax considerations are quite different. (Tax considerations are discussed more completely in Sec. III.) Further, several policy considerations that are irrelevant in private sector leasing can influence decisions regarding public sector leasing. For example, government policy, as reflected in OMB Circulars A-76 and A-94, encourages reliance on the private sector whenever possible. Because leasing relies more on privately held resources and management, thereby reducing use of government personnel and facilities, it helps implement this policy. Risk bearing considerations are also different in the case of public sector leasing, as Sec. III discusses in more detail.

In contrast to the private sector, where a wide variety of leases have been tried, only a small portion of possible public sector leases have been employed. Figure 2.1 summarizes actual and proposed government satellite leasing experiences. The figure distinguishes among several characteristics of leasing contracts. In the first (vertical) dimension, we distinguish between leased *services* and leased *equipment*. For leased services, the lessee specifies performance requirements and the lessor then assumes major responsibility for the asset's operation and maintenance (O&M), including tracking and control (T&C) and insurance against service failure or interruption. Services range from entire systems to transponders to individual circuits. In the case of leased equipment, the lessee specifies hardware requirements and assumes responsibility for O&M, T&C, and insurance. The second dimension of Figure 2.1 indicates that leased services and/or equipment may either be shared with other users or dedicated for exclusive use by the government. The third dimension distinguishes between leasing existing or new, still undeveloped services. This distinction can be important because of the differing degrees of technical risk.

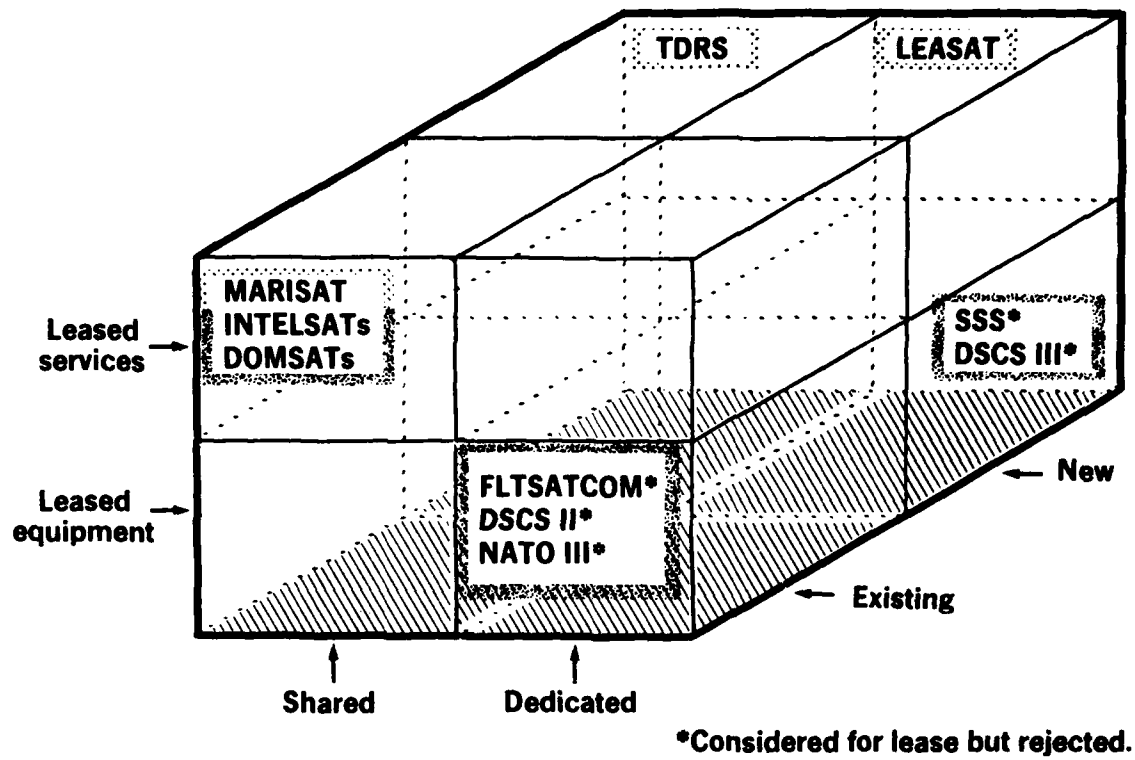


Fig. 2.1 -- Range of MILSATCOM Leasing Options

The earliest government leasing experiences involved existing shared commercial circuits. The DoD began leasing communication services from international satellites (INTELSATs) in the early 1960s. Leasing of domestic satellite (DOMSATs) capacity dates back to the early 1970s.⁸

As Fig. 2.1 indicates, nearly all of the government's leasing experiences have involved shared systems. Further, all of the shared systems have entailed leased services rather than leased equipment. Each of these represent cases where the government's demand for communication services did not require the entire capacity of the satellite. In these cases, had the government leased or purchased the equipment, it would have been necessary to sublease the unused capacity. Instead, private entities retained title to the equipment and provided the necessary brokerage services. The LEASAT system represents the only instance in which satellite services were leased and the satellite was not shared. It is notable, however, that the LEASAT contract was apparently designed primarily for taking advantage of tax considerations.

Apart from LEASAT, the government has never actually leased a dedicated satellite system. Several dedicated systems have been considered for lease but rejected. Lease-versus-buy cost comparisons have been conducted for additional existing FLTSATCOMS, DSCS IIs, and NATO IIIs. These studies have argued that leasing would be more expensive than buying by approximately 200 percent,⁹ 65 percent, and 68 percent.¹⁰ As Sec. III explains, however, these analyses may seriously bias results against leasing because of the way they handle the costs of risk bearing by the public sector.

⁸DoD is the largest international customer of leased satellite circuits. Spending in 1982 exceeded \$52 million (*Telecommunications Report*, Vol. 48, No. 42, October 18, 1982).

⁹House Appropriations Committee, *Department of Defense Appropriations for 1979*, p. 536.

¹⁰Defense Communications Agency, MILSATCOM Systems Office, *Lease Versus Buy Considerations for MILSATCOM Systems*, Technical Report No. 80-1, pp. 21.

To date, only three MILSATCOM systems, MARISAT, TDRS, and LEASAT, have been leased. Given this limited information base, it is virtually impossible to isolate the effects of the decision to lease rather than buy on the performance of these systems. Nevertheless, a brief review of the performance of these systems is instructive. The following discussion compares the three leased MILSATCOM systems on the basis of five performance criteria cited in the policy debate as important considerations in the choice of lease versus buy:

- (1) the extent to which cost growth was controlled;
- (2) schedule delays;
- (3) whether the system uses proven or new, unused technologies;
- (4) the reduction in military staff requirements and control over system design; and
- (5) the extent to which risk bearing was actually shifted to private corporations.

We list these criteria in the left-hand column of Figure 2.2. In the remaining columns, we compare the results of three systems, MARISAT, TDRS, and LEASAT.

The MARISAT Program

The MARISAT system, leased from the Comsat Corporation, currently provides communication services to the U.S. Navy, the Army, the Air Force, and the Joint Chiefs of Staff, as well as to the commercial merchant fleet. MARISAT is comprised of three satellites, one each over the Atlantic, Indian, and Pacific Oceans. The system is also called the GAFILLER or GAPSAT program because the Navy originally used it to fill a gap in its tactical communications capabilities created by the failure of TACSAT I (in 1972) and the unanticipated delay in the follow-on system, FLTSATCOM. In 1973, the Navy signed a fixed price lease contract for \$27.9 million for two years, with options to renew the service for a third year. Responsibility for tracking and control stations, system operations, and reliability of service was assumed by Comsat. The MARISAT design was within the current state-of-the-art, contained no anti-jamming capability or government furnished equipment

CRITERIA	MARISAT	TDRSS	LEASAT
COST	Controlled	Cost growth	Controlled
SCHEDULE	Delay*	No delay*	No delay*
PERFORMANCE	Excellent Proven	Problems** Proven/Unproven	Excellent** Proven
PUBLIC MANAGEMENT	Reduced	Reduced	Reduced
PUBLIC-PRIVATE RISK SHARING	Risks shifted	Risks shared	Risks shifted

*Delays in program not due to leasing, but to shuttle schedule slippage.

**Based on initial in-orbit experience since 1984.

Fig. 2.2 -- Evaluation of Leased MILSATCOM Systems

(GFE), and had less communications capacity than the proposed FLTSATCOM. The MARISAT program has performed exceedingly well, and the Navy has continued to renew its lease option.

Cost and Schedule. The MARISAT program experienced some unanticipated intermodulation problems during development that caused a slight cost overrun (5 percent) and a delay of 13 months in an ambitious 17-month schedule. However, according to the program's technical manager, the intermodulation problems were probably solved more expeditiously and at lower cost than they would have been if MARISAT had been procured under a purchase contract. Although in principle a purchase contract could be structured to provide similar incentives, leasing undeniably provided Comsat with strong and direct incentives to

deliver a reliable system within the date and price agreed to in the Navy contract.

Performance. Consistent with expectations, MARISAT has performed excellently through its use of proven technology. System availability has exceeded 99.9 percent.

Management. Buffered by Comsat, the Navy has had less access to the developer, Hughes, than it would have had under a conventional buy program. Moreover, because the MARISAT system is shared with non-DoD users, DoD program managers have had to adjust their management style. Nevertheless, the Navy was kept well informed by Comsat, and all development problems were successfully resolved.

Risk Sharing. Comsat apparently had little difficulty financing the relatively modest MARISAT development costs. Thus, financial risks were fully shifted from the government to the lessor. Of course, the lease price includes compensation for these risks, as Sec. III discusses in detail.

The Tracking and Data Relay Satellite (TDRS) Program

The TDRS program provides a more ambiguous picture. In particular, because of numerous technical problems, the government ultimately assumed most of the financial risks associated with the program. Thus, while TDRS was leased initially, subsequent contract modifications eliminated the central risk bearing feature of a lease contract.

TDRS was originally intended to be a shared system, leased by NASA from Western Union Spacecom (a joint venture with Fairchild Industries and Continental Telecom) to track and provide two-way data communications linkages with other NASA satellites. Services were to be shared with the Advanced Westar domestic satellite communication system. Six identical spacecraft were to be built: three operational and three spares. However, shortly after a seriously flawed first launch in April 1983, Western Union cancelled its plans for shared use and sold its 50 percent ownership of Spacecom to the other two partners. The restructured contract granted NASA sole use of TDRS and Spacecom received a \$35 million advance payment (of which \$29 million was used to buy Western Union's share).¹¹ But, because of multiple failures of

¹¹"Fees Held Until Satellite in Proper Orbit," *Electronic News*, April 11, 1983.

TDRS-A, NASA is deferring acceptance. If NASA decides to impose penalties against the contractors, Spacecom and TRW, a multiyear legal battle could result.¹²

NASA was originally interested in developing a TDRS system for two principal reasons: cost reduction and performance improvement. By relying on cross-linked satellites to receive, transmit, and relay data, NASA expected that it could close many of its expensive and remote ground stations and improve coverage of its low altitude earth orbital satellite missions.

The decision to lease rather than buy the TDRS system was prompted primarily by budget constraints that would not permit funding for a major new development program simultaneously with the multi-billion dollar Space Shuttle Program. Leasing was intended to allow NASA to defer payments of principle and finance TDRS out of its Operations and Maintenance Account instead of its Capital Procurement Account, which was financing the Space Shuttle. Thus, the decision to lease TDRS was not the result of efforts to lower the real costs or improve the performance of the system, but rather reflected considerations of cash-flow and budgetary politics. (See Sec. III below.)

Contrary to MARISAT's successful record, TDRS has encountered serious financial and technical problems, as indicated below.

Cost. Originally, TDRS was estimated to cost \$786 million (in 1976 dollars). It is now estimated to cost more than \$1,800,000 (in 1982 dollars)--an increase of over one-third in real terms. The cost growth is primarily attributable to high interest costs, Space Shuttle delays, the decision to switch to all Shuttle launches, and negotiated modifications.

Schedule. Although there was a three-year delay in the first launch, this was almost entirely attributable to Space Shuttle slippages. Delays in the second and third launches are partially attributable to further testing of the Inertial Upper Stage (IUS) booster that malfunctioned during the first launch.

¹²"TDRS Failures May Result in Legal Battle," *Aviation Week and Space Technology*, Nov. 28, 1983.

Performance. TDRS's performance cannot be fully judged until all the spacecraft are built, launched, and operating in orbit. Some comments, however, can be made about major problems that have occurred to date.

The first, a major technical problem involving Radio Frequency Interference (RFI), was discovered during the development phase. According to those involved in the TDRS program,¹³ it is unlikely that the RFI environment would have been adequately specified even if TDRS had been a buy program. Only some of the people writing the performance specifications had access to the highly classified information necessary to recognize the potential RFI problem. Moreover, once the problem was identified, the method of solution would probably not have been much different if TDRS had been purchased.

Multiple technical problems have seriously degraded the performance of the first and only launched TDRS. Not only did TDRS-A initially fail to achieve its correct orbit due to a malfunction of the IUS booster, but after successfully arriving on orbit (following lengthy and fuel-consuming maneuvers), it experienced an electronics malfunction that resulted in the loss of a high data rate communications link. Scientists are still trying to determine the specific causes of these failures. In general, however, these problems reflect the high level of risk related to the advanced technology involved--characteristics the system would have whether leased or purchased.

Program Management. Under leasing, NASA had considerably less leverage over the contractor, TRW, regarding design and development problems. Those involved in the program argue that leasing is a very inflexible strategy for developing advanced technology. NASA officials argue that they could not provide any technical direction to the contractor except by changing and renegotiating the entire service contract. As a result, costly delays developed in documenting and negotiating the many technical changes (over 200) made during the system's development. Nevertheless, it is unclear how easily these difficult changes could have been accommodated under the purchase option. These management problems in the leased TDRS program contrast

¹³Based on interviews with NASA officials, October 1980.

with the smooth management of MARISAT, a program lauded because leasing ostensibly provided strong incentives to the satellite supplier to satisfy user requirements.

Risk Sharing. In the case of TDRS, leasing did not succeed in shifting financial risks from the government to the lessor. Because Western Union was unable to obtain adequate private financing at acceptable rates, NASA arranged financing through the Federal Finance Bank (FFB). The government thereby guaranteed repayment of loans to any lender, regardless of the program's outcome, and, in effect, assumed *all risk* except for costs less than \$30 million--the extent of Western Union's liability.

The LEASAT Program

LEASAT, the first system acquired under the new DoD leasing policy, is a follow-on system to FLTSATCOM providing worldwide UHF communication services to ships, submarines, Navy aircraft, and other mobile users. Leased by the Navy directly from a wholly owned subsidiary of Hughes Aircraft Corporation, Hughes Communication Services, Inc. (HCSI), the system will consist of five satellites. One will remain on the ground as a spare and the others will be placed in orbit over the Atlantic, Indian, and Pacific Oceans. The Navy will pay \$335 million for the LEASAT system, a \$67 million per year lease rate for five years.

LEASAT is based on a proven Hughes design, Syncom IV. It differs in several ways from its predecessors, MARISAT and FLTSATCOM. LEASAT has less capability than FLTSATCOM, mainly due to the elimination of some Air Force-related mission requirements. But, unlike MARISAT, LEASAT has a substantial amount of GFE, including dual channel on board processors for each spacecraft and encryption devices.

Financing for LEASAT is provided by a leveraged leasing arrangement designed to exploit tax advantages. HCSI sells the satellites to a group of banks once the satellites are launched and tested in orbit, and then leases the satellites back for seven years while simultaneously leasing them to the Navy for five years. After the HCSI-Navy lease expires, HCSI may lease services to other users or the Navy can extend its lease.

LEASAT, originally scheduled for launch in 1980, was designed exclusively for Space Shuttle launch. However, due to the three-year Shuttle Program delay--not explicitly accounted for in the lease contract--LEASAT's schedule was slipped by HCSI and the Navy until August 1984 (first launch). Revising the schedule, however, involved contract renegotiation. Under the new agreement, the Navy will provide some advance funds drawn against future lease payments to supplement privately raised funds for continued system development and production. In return, the Navy is allowed some increased flexibility in service availability dates.

Although the LEASAT program cannot be adequately assessed without more extensive in-orbit performance experience, some preliminary observations can be made.

Cost. There have been no cost overruns. Even under the renegotiated payment process that allows advance payments, total costs will not be increased.

Schedule. LEASAT delays are related entirely to slippage in the Space Shuttle schedule.

Performance. We cannot fully assess performance until all the spacecraft are launched. However, in-orbit performance of the first two has been excellent. Furthermore, leasing has provided Hughes flexibility in resolving system development problems. And, LEASAT is designed to meet the Navy's performance specifications with proven technology.

Management. Although the Navy's LEASAT management staff is small, fewer than 10 people, this has been adequate, because the Navy has had ample access to the contractor. Both the Navy and Hughes consider LEASAT a well run program.

Financing. HCSI has assumed all financial, technical, and performance risk. The advance payments that HCSI will receive under the renegotiated contract will be on a "warranty pay back" basis; if service fails, HCSI must pay the Navy back.

III. LEASE VERSUS BUY CONTRACTS: THE RELATIVE COSTS OF RISK BEARING AND OTHER CONSIDERATIONS

As Sec. II demonstrates, the wide variation in government experience with satellite leasing has led the parties in the lease versus buy policy debate to contrasting and sometimes internally inconsistent conclusions. No consensus on the effects of MILSATCOM leasing has emerged, in part because no consistent analytical framework has been used to compare outcomes under the lease and purchase options. This section isolates the critical factors affecting the choice of lease versus buy contracts. The first part of the section examines past arguments in the lease versus buy debate. While past studies suggest some important ancillary issues, they have not examined the central differences between contractual mechanisms. The economic difference between a lease and purchase lies in the distribution of risk. The latter part of this section discusses the implications of risk bearing under the lease and purchase options.

THE HISTORICAL DEBATE IN PERSPECTIVE: SEPARATING FACT AND FICTION

The proponents and opponents of leasing have made wide-ranging arguments and allegations regarding the relative performance of leased satellite communications systems. Advocates of leasing in the House Appropriations Committee and elsewhere have argued that leasing would: reduce MILSATCOM costs by shifting risk to the private sector and changing the incentives of suppliers; alter the design of satellite systems by encouraging the use of proven and reliable technologies; and reduce administrative costs and increase private sector involvement by shifting administrative and procurement responsibilities from the public to the private sector.

Opponents of leasing in the Department of Defense (DoD) argue that leasing would reduce vital DoD control over system operation and development and fail to provide desired performance characteristics, especially in high-risk wartime communications systems. They also argue that leasing would substantially increase, not decrease, costs by shifting risks to private firms.

Past leasing experiences reveal other arguments about the advantages and disadvantages of this form of contract. For some organizations, leasing has appeared advantageous because the agency can compete for funds in the budgeting process in the operation and maintenance accounts rather than in the construction accounts. In other cases, leasing has occurred because of its tax effects. It has also been argued that leasing allows society to fully utilize satellite capacity through shared leasing agreements.

An examination of several key issues helps to identify the arguments that are irrelevant to the lease versus buy decision, and to focus the analysis on questions of central importance.

The Effects of Leasing on System Design

Several arguments in the lease versus buy debate suggest that the decision to lease will independently alter the design of a MILSATCOM system. Indeed, both sides seem to agree that leasing leads to the development of technically simpler systems that rely on conservative, proven technologies. The primary disagreement is over the desirability of such changes. However, there is little basis for the conclusion that leasing itself will affect system design.

The notion that leasing contracts necessarily lead to less sophisticated systems appears to rest on one of two propositions, depending upon which side in the debate is making the argument. Proponents argue that leasing provides satellite producers strong incentives to supply conservative designs to avoid the technical and financial risks of more sophisticated systems. They point to the success of MARISAT to support this argument. Opponents argue that leasing does not allow the government sufficient flexibility to monitor contractor performance and ensure delivery of MILSATCOM systems that satisfy national security requirements, and conclude that TDRS has been unsuccessful largely because leasing insulated the satellite developer from NASA monitoring and control.

In fact, leasing itself does not create incentives to avoid higher risk technologies. If a supplier is not offered an adequate risk premium, it will certainly avoid taking risks. But this is an argument

not against leasing, but against trying to get something for nothing. The important questions about supplier incentives are these: How large a risk premium is necessary under a lease to induce desired behavior, and how does this cost compare with the cost of carrying the risk publicly under the buy option?

Neither is it the case that leasing necessarily inhibits DoD control over performance characteristics. The specifications for a MILSATCOM system should depend on national security considerations, not on the form of contract chosen to secure communication services. The problems inherent in specifying "essential" features have nothing to do with whether the system is purchased or leased. In some cases, it may be desirable to provide certain performance characteristics through government furnished equipment (GFE), but this could occur under either a lease or purchase. Further, in the case of some wartime systems, DoD could specify hardware, as well as performance, requirements in a lease contract. Under either form of contract, competitive pressures in the marketplace should provide strong incentives for firms to satisfy the technical requirements of a major customer like DoD.

Only in the case of a shared satellite system might the ability of DoD to control system design be compromised. When a satellite is shared, the various users may have conflicting demands for the technical specifications. If, for example, the satellite manufacturer acquiesced to the demands of a single user (e.g., DoD), the value of the asset to other users could decline. National security considerations may preclude the sharing in highly classified, wartime systems. In these cases, it is imperative that DoD have control over system design and specifications, and the appropriate comparison is between purchased and leased dedicated systems.

Public Versus Private Administration

Leasing has sometimes been recommended because it encourages the use of private resources to manage and procure communications services and reduces reliance on the public bureaucracy. Two rationales appear to underlie the desirability of this outcome: First, to the extent that private management does replace public management, leasing advances government policies as stated in OMB circulars A-76 and A-94. Second,

it is argued that because leasing reduces the burden of public administration, it reduces MILSATCOM costs.

While leasing clearly can advance policy objectives encouraging the use of private over public resources, it is far from clear that it reduces administrative costs. Leasing does not eliminate the need for careful procurement and administration in providing communication services. Leasing may transfer costs from the public to the private sector. But the resulting decline in public administrative costs may be larger or smaller than the increase in private administrative costs. In either case, it makes sense to have the most efficient organization provide administrative and procurement services. Whether DoD provides these services or private firms are paid to provide them, risks could still be borne publicly, as under a purchase, or privately, as under a lease.

Tax Considerations

Taxes are a dominant consideration in lease versus buy decisions in the private sector and have also affected government decisions, most notably with respect to LEASAT. The decision to lease or buy can strongly affect tax incidence. However, these shifting tax burdens represent only redistributions of income. They do not alter the social costs of a MILSATCOM system. Consequently, we do not believe that tax considerations provide a sound basis for long-term policy on lease versus buy decisions.

Leasing can affect tax payments in at least two ways. First, leasing may increase corporate income tax revenues. If corporate shareholders and managers are risk averse, they will demand higher profits, on average, under leasing to compensate for increased risk bearing. As a result, corporate tax payments, on average, will be higher. However, in a competitive market, the increased tax liability will be paid for by a higher asking price for the satellite services.

Perhaps more important, leasing can have powerful effects on taxes paid under other tax provisions, such as the investment tax credit (ITC). When the government purchases a satellite system directly from the manufacturer, no ITC savings accrue to the productive asset simply because the government by definition pays no taxes. In contrast, a

leasing arrangement can be structured to lower substantially the taxes paid by private sector corporations. If the ownership rights to the system are, for example, acquired (and retained) by a private sector firm, the satellite system can qualify for the ITC. Because MILSATCOM systems are very expensive investments, the potential tax savings from these activities can be very substantial. In a competitive market, these tax savings will be passed on to the lessee, seeming to reduce the cost of the system to the government. Of course, any reduction in the DoD budget for MILSATCOM systems is directly offset by an equal reduction in government revenues. From the individual government agency's perspective, the tax savings of leasing may be beneficial. While the agency enjoys the full benefits of reduced expenditures, the fiscal impact of the reduced tax revenues will likely be spread throughout the federal budget. But from the perspective of the economy as a whole, no advantage or disadvantage to leasing is implied.

Alternatively, the ITC savings may not be completely passed on. This outcome would imply a lack of competitiveness among satellite suppliers. While an examination of the competitiveness of satellite markets lies beyond the scope of the present study, we are aware of no evidence that conclusively shows a lack of competition and none that demonstrates a lower degree of competition under a lease contract than a purchase contract. If a lack of competition did prevent full pass-through of tax savings, income would be redistributed to the shareholders of the private corporation at the expense of general taxpayers or the recipients of government services. If such an outcome requires a public policy remedy, increasing the level of competition would seem more appropriate than deciding to lease rather than buy.

Lease Versus Buy in the Budgeting Process

In the private sector, leasing is sometimes used because it is an "off-the-balance-sheet" method of finance--that is, leasing does not affect the long-term debts or assets of the lessee. In the public sector, leasing has been favored on some occasions for similar reasons.

The Navy's experience in leasing tankers illustrates the role leasing can play in budgetary decisions.¹ In 1972, after repeated

¹As Section II notes, this rationale for leasing was also evident in the TDRS experience.

failures to obtain funds to purchase tankers, the Navy's Military Sealift Command (MSC) decided to lease nine specialized vessels. The MSC had been unable to compete with higher priority combat ships for construction funds to build the tankers. Through a leasing contract, the funds were obtained instead from the operations and maintenance account.²

While such episodes may indicate an element of success for a particular government agency, they do not provide a very sound basis for making lease versus buy decisions in the long term. Loopholes in oversight procedures could be closed quickly if O&M accounts were scrutinized as closely as construction and long-term capital accounts. Indeed, if leasing were used very often to alter allocative decisions, revisions in current procedures would be inevitable. As noted above, decisions on expenditures for military systems should depend upon national security considerations and the relative costs of these systems, rather than on how a lease as opposed to a purchase affects budgetary politics.

Shared Systems

With few exceptions, actual government satellite leasing experiences have been with shared systems--satellites with capacity that exceeds government demand. Because of the high launch costs of placing a communications satellite into orbit, it is not economically feasible to produce satellites below a certain capacity. In principle, the large capacity of these satellites does not make it imperative that the government lease rather than buy. If other advantages to purchasing were sufficient, the government could purchase the system and lease excess capacity to other users.

In practice, however, important institutional considerations constrain the government's ability to own and lease resources to the private sector. Certainly, this option runs counter to the goals of increased reliance on the private sector expressed in circulars A-76 and A-94. More generally, the government traditionally plays a limited role in private market decisions. If the government subleased capacity, the DoD would be in direct competition with private suppliers of

²For a description of this program, see Jackson and Clapp (1975).

communications services. Consequently, leasing may often make sense when sharing capacity makes sense.

Peacetime or wartime systems for which government demand or national security considerations mandate the use of dedicated systems are more problematic with respect to the lease versus buy issue, partly because they represent such enormous expenditures and partly because they have little or no useful commercial residual value after the lease expires. For these systems, lease versus buy decisions cannot be evaluated without considering the costs of risk bearing.

THE COSTS OF PUBLIC VERSUS PRIVATE RISK-BEARING

By far, the most important factor affecting the choice of lease versus buy is the cost of risk bearing under these alternative forms of contract. The parties in the policy debate reach opposite conclusions about who can best shoulder the inherent risks of a MILSATCOM system--taxpayers (under the purchase option), or shareholders of private corporations (under the lease option). The stakes involved in such a decision are potentially enormous, especially for high-risk, high-cost systems capable of providing wartime communication services. The social costs of a particular satellite system can vary widely solely on the basis of how risks are distributed. Risk bearing imposes costs in the truest economic sense of the term: Exposure to risk reduces the economic well-being of individuals. The social cost of risk, under either lease or buy, equals the sum of these individual costs.³

Whether risks are borne at a lower cost under a lease or purchase contract ultimately depends on two questions: First, while it is generally agreed that risks privately borne impose a social cost, is there any cost associated with risks borne by the government? Second, if publicly borne risk is not costless, is the risk premium that would be required to compensate the taxpayers who bear risk larger or smaller than in the case of privately borne risk? Although the first question has sparked much controversy among economists, it can be answered

³For a contrary view, see Eckstein (1961) and Marglin (1963). These analysts suggest that conclusions about public risk bearing should not necessarily be based on (market-revealed) individual preferences, but rather on policy objectives determined centrally by national policymakers.

unambiguously in the affirmative: Government-borne risk does impose social costs. Moreover, these costs have been uniformly ignored in previous studies of lease versus buy, and a serious anti-leasing bias is the result. The second question has no unambiguous answer. The costs of public risk bearing may be more or less than private risk bearing. For any given investment project, the magnitude of the public cost advantage or disadvantage will depend upon a variety of economic characteristics, which may often be exceptionally difficult to evaluate.

Technical Risk and Financial Risk

Technical risk in a MILSATCOM system is unavoidable, particularly in wartime communications systems which stretch the limits of advanced technology. To accomplish its mission in facilitating warfighting command, control, and communications, a MILSATCOM system must incorporate several crucial characteristics: mobility, for communicating with small transportable, remote ground terminals and for providing proliferated ground control of satellite operations; security, for both the command up-links as well as the telemetry down-links, provided by anti-jamming techniques and encryption devices; physical survivability, provided by such means as nuclear or laser hardening and spacecraft maneuverability; and endurance, which might be achieved by autonomy, reconstitutability, or other means.

The incorporation of such characteristics is subject to considerable technological uncertainty. For this reason, MILSATCOM systems often include back-up systems. However, if the entire system fails, little can be done beyond writing off the investment as a loss and incurring the costs of developing an improved system. Leasing does not alter these technical risks. These risks are a function of the sophistication of the required service characteristics, the state of the technological arts, and the skill of their application. As discussed in previous sections, leasing by itself does not necessarily alter any of these considerations. If backup systems are required, or if costs must be otherwise incurred to develop an improved system, these activities and the amount of resources they consume will be the same under lease or buy.

Differences between leasing and buying emerge only when we consider *financial* risks. When a system does not perform up to expectations, the satellite/asset is devalued. In an extreme case, the resources embodied in the satellite become valueless. As emphasized in Sec. II, the primary difference between a lease and a purchase is who bears the financial consequences of a technological failure.

Note that the critical consideration is not the distribution of benefits, but rather the distribution of costs. A MILSATCOM system is an excellent example of a pure public good, and the distribution of benefits is the same under lease or buy. However, the distribution of costs differs. Under a lease, the financial burden of a failure falls upon the private sector titleholders, since the government lessee is not required to pay for satellites that provide no communication services. Under the buy option, this burden is carried by taxpayers who not only incur the costs of developing an adequate replacement communication system, but of the failed system as well.

Risk Aversion and the Cost of Leasing

Economic agents are risk averse. This means they will not bear risk voluntarily, unless paid to do so. If competitive bids were solicited with the requirement that the winning contractor lease a dedicated satellite system to the government, the resulting bids would almost certainly be higher than if the identical system could be sold outright to the government.⁴ This is because the contractor would be accepting the financial risk inherent in a MILSATCOM system and would demand payment for that service.

If investors in defense contracting firms were risk neutral, competitive bids offered under a lease would result in the same costs on average as those under a purchase. Risk neutral investors would bid such that expected lease revenues equal expected construction costs (including the opportunity cost of capital). In some cases, the contractor would suffer large losses and in others it would make large

⁴Exceptions to this conclusion would almost certainly be best explained by looking to the tax codes, which we have argued provide a questionable basis, at best, for lease versus buy policy decisions.

profits. But over a large number of lease contracts, the contractor would earn a competitive return on its investment equal to the risk-free rate--the same outcome as under the buy option. Risk averse investors, however, will not accept an actuarially "fair" business gamble. Rather, they will undertake a risky project only if expected revenues exceed expected costs. The amount by which expected revenues must exceed expected costs to make the project attractive is called the "risk premium."

Table 3.1 demonstrates the effects of risk bearing on the expected expenditures from the defense budget to acquire a MILSATCOM system. These calculations are based on a hypothetical high-cost, high-risk

Table 3.1

MILSATCOM SYSTEM BUDGET COSTS:
EFFECTS OF PRIVATE RISK BEARING
(BILLIONS OF DOLLARS)

	Required Annual Rate of Return			
	Risk Free	Including Risk Premium		
	10%	15%	20%	30%
Buy Option				
Undiscounted Costs	5.0	--	--	--
Present Value	3.8	--	--	--
Lease Option ^a				
Expected Annual Lease Payment	1.1	1.7	2.5	4.8
Expected Undiscounted Costs	9.2	13.6	19.7	38.5
Present Value ^b	3.8	5.6	8.1	15.9

^aCalculations assume construction costs of \$1 billion annually for a five-year construction period, followed by an eight-year service period during which lease payments occur annually.

^bPresent value of expected annual lease payments to the government, discounted at 10 percent.

system such as MILSTAR, a new system designed to satisfy full wartime capabilities as defined by the Joint Chiefs of Staff. We assume that the communications system involves construction costs (ignoring risk) of \$1 billion annually over a five-year construction period. Accordingly, under a buy option, budget appropriations over the five-year period would amount to \$5 billion. Using an assumed risk-free opportunity cost of capital of 10 percent (consistent with OMB circular A-76), the present value of the budget costs of the system is \$3.8 billion under a purchase contract.

The lower part of Table 3.1 shows estimated budget appropriations under a lease. These calculations assume that the contractor receives annual lease payments during an eight-year service period. If the system is risk-free, annual lease payments would be slightly more than \$1.1 billion and the deferred budget appropriations for acquiring the system would amount to \$9.2 billion. However, in this case, leasing and buying differ only in the timing of payments, and the present value of system costs to taxpayers remains \$3.8 billion.

When the riskiness of the system is taken into consideration, the expected costs of leasing begin to rise. The effects of risk are incorporated in Table 3.1 through the use of different risk-adjusted required rates of return. Risk averse contractors will not find an expected 10 percent rate of return acceptable under a lease. Table 3.1 considers three additional annual rates of return--15, 20, and 30 percent--each reflecting higher respective risk premiums.⁵ If a rate of return as low as 15 percent will compensate private risk bearers, expected annual lease payments rise to 1.7 billion over the eight-year service period.⁶ The present value to taxpayers of these costs (again,

⁵In these calculations, we incorporate the costs of risk by altering the relevant discount rate. While this method provides an adequate illustration of the effects of risk bearing, under some circumstances the costs of risk cannot be measured precisely by merely changing the discount rate. For a discussion of this point, see Lind (1982).

⁶To simplify the analysis, Table 3.1 and the discussion in the text summarize the cost of leasing in terms of *expected* values. That is, the leasing costs in these examples indicate the amounts that the government should expect to pay, on average; they do not correspond to actual budget outlays. Actual payments would depend upon the expected

using the taxpayers' 10 percent discount rate) is \$5.6 billion--an increase of nearly 50 percent over the present value of budget appropriations under the buy option.

Similarly, if risk considerations mandate a higher expected rate of return for the contractor, the difference between leasing budget costs and purchasing budget costs expands. At a 20 percent risk-adjusted rate, expected annual lease payments approach \$2.5 billion and the leased system's expected present value budget cost is more than twice the buy option. If the system is so risky that in a competitive market it would warrant an expected rate of return of 30 percent, undiscounted budget appropriations for the same technical system would be nearly \$50 billion on average and the present value of the stream of expected lease payments soars to \$15.9 billion.

The hypothetical examples in Table 3.1 must be interpreted cautiously. The higher payments required under leasing do not reflect an increase in the wealth of defense contractors. These higher appropriations merely reflect fair (i.e., competitive) payments for risk bearing. In short, the difference between the present value of buy and the present value of lease in Table 3.1 is the social cost of private risk bearing under a lease. In all cases, the "certainty equivalent" value of the lease payments to the contractor is just \$3.8 billion, the same revenues as under the buy option.⁷

Table 3.1 does *not* suggest that leasing is more costly than buying MILSATCOM systems. It shows only that increased private risk bearing raises the budget costs of a system. The budget costs for the buy option do not reflect the possible costs of risk bearing. To compare the true social costs of the different contractual options, we must assess the relative costs of risk borne by the government.

probability of success. For example, if the probability of building a successful system is, say, 50 percent, then the leasing contract (assuming the 15 percent return in Table 3.1) would specify annual lease payments of \$3.4 billion. The \$1.7 billion figure discussed in the text represents the expected value of the implied "lottery" to the government: a 50 percent chance of paying nothing for a failed system and a 50 percent chance of paying \$3.4 billion for a successful system.

⁷The "certainty equivalent" is the amount required for the contractor to be indifferent between a payment with certainty and the "lottery" implied by a risky project.

The Cost of Government Risk Bearing

How much does it cost society to shoulder risk through the government? It turns out that this is an exceptionally difficult question, that has sparked much controversy among economists.

Some economists hold that risks borne by the government are without cost. Samuelson (1964) and Vickrey (1964), for example, argue that because the government pools so many risky projects together, the risks imposed on individual taxpayers by any single additional project are virtually nonexistent. Arrow (1966), Arrow and Lind (1970), and Arrow and Kurz (1970) reach a similar conclusion through slightly different reasoning. They argue that government spreads risks across so many taxpayers that, for practical purposes, the portion borne by any individual taxpayer is miniscule and can be ignored.

These arguments have come under attack by other economists, some of whom argue that public investments should reflect the opportunity cost of capital in similar projects in the private sector.⁸ Both of these extreme positions have direct policy implications. If risk borne by the government is without cost, then the least costly policy is to purchase risky MILSATCOM systems. Alternatively, if the opportunity cost of private capital is the yardstick, then there are no cost differences in the long run between leasing and buying. While leasing would increase the budget costs of communication systems, the corresponding increase in taxes would equal the benefit to taxpayers of shifting risks to the private sector. Thus, one argument suggests that we should buy MILSATCOM systems; the other suggests that neither contractual mechanism is preferred on the basis of social cost. Unfortunately, both of these commonly held views oversimplify important aspects of the risk bearing problem.

The argument that government risk is costless implicitly underlies much of the previous research on lease versus buy. However, this conclusion does not hold up. Pooling of risky projects cannot completely eliminate risk.⁹ All financial economists agree that it is

⁸The most prominent advocate of this position is Hirshleifer (1965, 1966). See also Baumol (1968), Diamond (1968), and, for a nontechnical discussion, Stokey and Zeckhauser (1978), Chapter 10.

⁹See Bailey and Jensen (1972).

impossible to eliminate certain "nondiversifiable risks," even in an economy with so-called "perfect and complete" financial markets.¹⁰ Notably, no economy has "perfect and complete" financial markets, a fact of life that increases the costs of risk bearing.

Moreover, mutual funds and other financial mechanisms allow privately held risks to be spread out over an extremely large number of individuals. Nevertheless, many assets in the private sector command a risk premium. This argument further suggests that government borne risks are costly, even if spread out over a large number of taxpayers.

In practice, whether it costs more to bear risks publicly or privately will depend upon a variety of economic factors that vary from case to case. To ascertain the correct answer for a particular MILSATCOM system, several difficult questions must be researched. These include:

- What is the "risk incidence" under alternative contracts? Theoretically, this issue could be addressed using standard methods of tax incidence analysis, although a myriad of empirical complications make this a difficult task.
- What options are available for risk spreading and what constraints are relevant under a lease and under a purchase? Important options include the purchase of insurance and risk hedging in securities markets, although access to these may not be identical for decisionmakers under lease versus buy.
- How does the risk imposed on individuals by the financing of a MILSATCOM system affect typical investment portfolios, since portfolio effects ultimately determine the cost of risk?
- Are there important differences between the risk preferences of those who bear risk under a lease as opposed to a purchase?

One important fact uniformly overlooked in the lease versus buy debate is that the risks of any given investment cannot be assessed on the basis of that investment alone. The effect of the risk on the portfolio of the risk bearer must be examined. Consider, for example, the purchase of a home insurance policy. By itself, the insurance policy has an uncertain payoff: The investment provides a return if the

¹⁰For a relatively straightforward discussion of financial theories of how the cost of risk affects asset prices, see Sharp's (1978) description of the "capital asset pricing model."

policyholder's home is destroyed, but provides nothing if the home is unharmed. By itself, an insurance policy is a risky asset. However, when combined with another investment, the policyholder's home, the insurance policy is part of a portfolio that can eliminate financial risk. The same considerations apply to a MILSATCOM system. The costs of its riskiness can only be determined in the context of the typical portfolio of taxpayers (under a purchase) or shareholders (under a lease).¹¹

Both taxpayers and shareholders can be protected from risk to some extent by the risk hedging activities of decisionmakers. If both the government and private contractors had equal access to financial markets, we would once again be driven to the conclusion that the social costs of a lease are equal to those of a purchase. In practice, however, government policymakers face various institutional constraints that largely prohibit direct access to financial markets. Thus, government risk bearing may be more costly than private risk bearing simply because the government may be less capable of appropriate risk hedging.¹²

Finally, the risk preferences of defense contractor shareholders may differ from those of the general taxpayer. In particular, defense programs are viewed as inherently risky in financial circles, largely because of the rapidly changing technologies and political vicissitudes affecting defense spending. It may be that these firms attract individuals who are less risk averse than the typical taxpayer. This proposition can only be addressed through detailed research on a case by case basis.

¹¹Bailey and Jensen (1972) and Hirshleifer and Shapiro (1969) make similar arguments in the context of assessing the risk of government investment projects. Others have suggested examining the correlation between the returns to a public investment and gross national product (see Sandmo, 1972, and Lind, 1982).

¹²Bradford (1975) provides a theoretical discussion of how constraints on government investment activity affect the cost of public risk.

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¹²Bradford (1975) provides a theoretical discussion of how constraints on government investment activity affect the cost of public risk.

IV. CONCLUDING REMARKS

In the growing controversy over the "best" strategy for acquiring MILSATCOM services, the various parties in the debate have adopted widely divergent positions. For the most part, however, the arguments advanced and the ultimate decisions reached regarding lease versus buy outcomes have not been based on a solid analytical foundation.

Both those who favor and those who oppose leasing have argued that this form of contract alters the incentives of MILSATCOM suppliers. Both have argued that leasing itself can alter the technical design of a communication system, with the result being exorbitant costs, according to leasing proponents, or compromised national security, according to leasing opponents. There is little evidence to support these views. Actual leasing experiences seem contradictory: While the success of MARISAT has been partly attributed to positive supplier incentives under leasing, the failure of TDRS has been partly blamed on the supposed failure of leasing to provide incentives for suppliers to be responsive to NASA requirements.

In practice, actual leasing decisions often appear to have been based on specific--and questionable--circumstances. In some cases, the decision to lease resulted from idiosyncrasies of the budgetary process, when agencies decided to compete for operation and maintenance funds rather than construction funds. In cases like LEASAT, leasing has been chosen over purchasing because of tax considerations. While these rationales for leasing can provide short-term benefits to the agencies and contractors, neither provides a solid foundation for long-term lease versus buy policy decisions. Ultimately, the allocation of defense resources should be based on national security considerations, not on which line item is affected in the defense budget. And while tax considerations can have powerful redistributive effects, they do not directly alter the social cost of a MILSATCOM system.

The central, but previously ignored, question in the MILSATCOM debate concerns the relative costs of private versus public risk bearing. The analysis of risk bearing in Sec. III leads to several conclusions:

- While leasing itself does not alter MILSATCOM *technical* risks, it does result in a different distribution of *financial* risks.
- Leasing will result in higher budgetary costs than a purchase. This budget cost gap will increase with the riskiness of the MILSATCOM system.
- Budget costs under a purchase understate the social costs of providing communications services.
- Actual costs of risk bearing reflect several economic characteristics that will vary from case to case.
 - the nature of technical risks;
 - the correlation of risks posed by a MILSATCOM investment with risks posed by other investments in the economy;
 - the ability of the government to hedge risks;
 - the distribution of system costs among taxpayers under a purchase and among private sector shareholders under a lease;
 - the risk preferences of these groups.

These findings reveal a difficult public policy conundrum. Under a lease, a competitive bidding system to award the contract will provide an explicit valuation of how much it costs private contractors to bear risks. Under a buy program, the costs of risk bearing by the government (i.e., by taxpayers) remain hidden. Unlike a lease, a purchase affords no mechanism through which the risk preferences of taxpayers enter public decisions. The basic question becomes: by how much must we adjust the budget costs of a purchase to compare lease versus buy outcomes on an equal footing.

Based on our analysis, we suggest a review of the current bases for making lease versus buy choices. This review should consider the appropriateness in the near term of risk bearing policy decisions based on such factors as tax savings and the budgetary process. In some cases, the lease versus buy decision may rest on other considerations--for example, the mandates of OMB circulars A-76 and A-94, which encourage increased reliance on the private sector, and the exploitation of economies of scale through shared, leased systems. Such considerations may tip the scale in one direction or the other for some systems, especially low-risk, peacetime systems. In these cases, the costs of risk bearing may be comparatively low. For high-risk, wartime systems, however, lease versus buy decisions require more careful

analysis, since the costs of risk bearing may be far more substantial for these systems.

To improve policy decisions regarding risk bearing, we further suggest that DoD consider revising the bidding process for MILSATCOM systems. Today, one of the more serious obstacles to lease versus buy decisionmaking is the absence of adequate information relevant to the policy choice. The competitive bidding system has the potential to provide a great deal of relevant information. Accordingly, the DoD should consider soliciting bids from contractors that specify terms for both lease and buy options on MILSATCOM systems. Both the costs of risk bearing and the costs of construction warrant careful consideration in the policymaking process. Unlike the current system, separate lease and buy bids could provide clear and separate information on construction costs and risk bearing costs. This information could lead to a better understanding of and improved methods for risk hedging.

Perhaps more important, the information could be used to support further research into the difficult issues surrounding the costs of public versus private risk bearing. Over the longer term, policy criteria for making lease versus buy decisions must await the answers to several important questions. These include:

- What is the "risk incidence" under alternative contracts? That is, how are risks distributed among taxpayers under a purchase and among shareholders under a lease?
- What options are available for risk spreading and what constraints are relevant under a lease and under a purchase?
- How does the risk imposed on individuals by the financing of a MILSATCOM system affect typical investment portfolios, since portfolio effects ultimately determine the cost of risk?
- Are there important differences between the risk preferences of those who bear risk under a lease as opposed to a purchase?

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